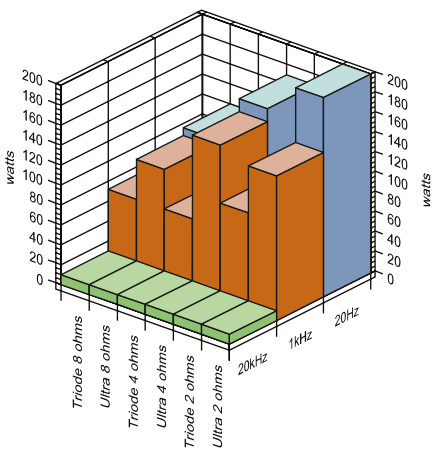
Rogue Audio

M-150 Monobloc Power Amplifier



Rogue Audio M-150 Power Output into 8Ω, 4Ω and 2Ω non-inductive loads, using 4Ω transformer tap and both triode and ultralinear output modes. (See legend under bar graph).

Why is Rogue Audio called Rogue Audio? There are some that say it's because the company's three founders, Mark O'Brien, Phil Koch and Mark Walker, were 'escaping' from the very rigid engineering philosophies espoused at their former—very prestigious!—workplace at Lucent Technologies, which is an integral part of Bell Labs. When it comes to pure research, Bell Labs is one of the heaviest hitters in the field. Since it was established in 1925, various of its employees have between them received six Nobel Prizes in Physics, nine US National Medals of Science, seven US National Medals of Technology and registered more than 31,000 patents. It's fair to say that researchers at Bell Labs have played pivotal roles in inventing or perfecting most of the electronics technologies currently in use today.

Mark O'Brien, who has advanced degrees in physics as well as an MBA, is the president of Rogue Audio and its chief designer. His design philosophy is centred around the principles of short signal paths, completely symmetrical left and right channels, the use of only the highest-quality components and, of course… valves: lots of valves! He, Koch and Walker founded Rogue Audio just on ten years ago with a simple guiding philosophy: never to build an amplifier they wouldn't be happy to purchase for themselves.

The Equipment

Rogue's M-150 monobloc power amplifier has four 6550s arranged in a push-pull configuration. They're driven by a pair of 12AU7 µ-followers, which is something of a signature circuit for O'Brien. A µ-follower is a way of taking a triode—or two halves of a dual-triode—and using one half as a constant current source. Because the current can't change, the voltage is amplified. Using two 12AU7s means each valve can operate in the most linear portion of its operating range, and what follows on naturally from this is that when amplifying a fairly small signal to 20 volts or more, you're driving the output stage without adding any significant distortion.

Rogue Audio

Brand: Rogue Audio
Model: M-150
Category: Valve Power Amplifier
RRP: $7,920 per pair
Warranty: Three Years (Six Months on Valves)
Distributor: The Audio Vision Network Pty Ltd
Address: Level 1 28 Bowden Street
Alexandria
NSW 2015
T: (02) 8396 6999
F: (02) 9699 6662
E: info@audiovisionnetwork.com.au
W: www.audiophilesdirect.com.au

It helps that µ-followers are very quiet and great at rejecting power-supply noise.

Another O'Brien 'signature' that features in the M-150 is his 'slow-start' circuit that he says extends valve life far beyond what's considered standard. He's also keen on dual-mode operation, so like most Rogue Audio amplifiers, the M-150 can be switched between ultralinear or pure triode operation.

For those readers who might not be quite clear on the difference between these two modes, consider that a triode is a tube that has three major components: a cathode (sometimes called a filament), an anode (sometimes called a plate) and a grid. When a positive voltage (several hundred volts or so) is applied to the anode, electrons on the cathode (which are negative) are attracted to the anode and move towards it. The grid, which is positioned between the anode and the cathode, modifies the flow of electrons between the two. Applying an audio signal to the grid of a triode results in the flow of electrons between the anode and cathode fluctuating in sympathy with the audio signal, but since there's a much greater number of electrons, the signal will be 'amplified.'

It's possible to add extra grids to a valve to get extra 'power' from the valve, but then the valve would no longer be a triode. Adding one extra grid turns a triode into a tetrode; adding two extra grids makes it a pentode. Although adding grids enables extra power, it also introduces extra distortion.

Another way to get more power is to use more valves, either in parallel or in 'push-pull.' In a push-pull mode, one valve 'pushes' the signal and the other 'pulls' it. When using triodes, the push-pull mode has the added benefit that the second-harmonic distortion that is produced by one valve is cancelled by the other, and since in a triode it's this second harmonic distortion that additionally limits useful output power, you can extract more power than if a parallel configuration were used.

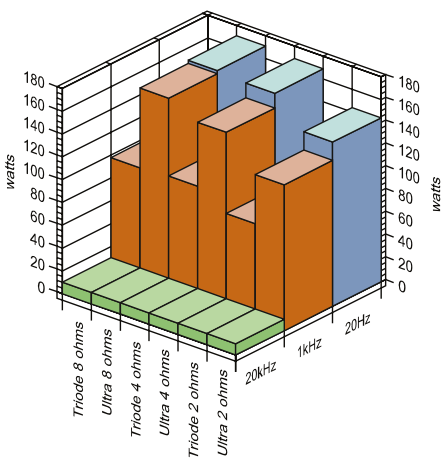
It's also possible to connect higher-powered pentode valves in push-pull mode, but in a pentode, output power is limited by third harmonic distortion, and this type of distortion doesn't neatly 'cancel' in the same way as second-harmonic distortion unless you connect the screen grids of the pentodes to the primary taps of the output transformer, a configuration that while it's generally known as the 'ultralinear' mode, is actually a compromise between the high efficiency of tetrodes and the low distortion and uncritical load impedance of triodes.

There's not a lot to the front panel of an M-150, as you can see for yourself, just that single power switch. It's around the back where all the action takes place. Here you'll find a 4Ω transformer tap at the far left and an 8Ω tap immediately alongside it where you connect your speaker. There are no (+) or (–) speaker polarity indications, which makes things a little trickier than they need to be. A little further along is a balanced input (via XLR) and an unbalanced input (RCA). Further along is the Ultralinear/Triode mode switch, alongside which is a Ground Lift switch, in the event that you experience hum caused by a ground loop. I'd recommend you first try to eliminate any ground loop that might exist by re-arranging your components, but if all else fails, it's nice that the Ground Lift is provided as a last resort. Alongside the Ground Lift switch is a standard IEC three-pin 240 socket and last, on the far right, a user-replaceable mains fuse. (There are, however, five other internal fuses: one each for the four power valves and one for the power supply.)

As you can see, the seven valves are at the back of the amplifier, protected by a metal cage. It's interesting that Rogue Audio's cage is almost completely open, which enables maximum heat dissipation—unlike the finely meshed metal cages found on many other valve amplifiers. I preferred Rogue Audio's cage. It's not visually intrusive and yet still protects the valves (and you!) from inadvertent damage. Sure you can poke your fingers in through the mesh if you want, but you'd have to do this deliberately—and relatively slowly—which would give you plenty of time to work out that the valves are hot.

You have probably guessed by the presence of a meter on the rear 'deck' of the amplifier that the M-150 is not an auto-biasing amplifier. You have to bias the valves yourself. Further, you have to bias each valve individually. Rogue Audio says that in designs that bias several valves at the same time, although the total current flowing might be correct for the group,

There are no (+) or (–) speaker polarity indications, which makes things a little trickier than they need to be.



Rogue Audio M-150 Power Output into 8Ω, 4Ω and 2Ω non-inductive loads, using 8Ω transformer tap and both triode and ultralinear output modes. (See legend under bar graph).

the current flow through an individual valve might 'vary significantly from the optimum value. When setting bias individually, the correct operating point is assured.' There is another very significant advantage to individual biasing, which is that there's no need to buy matched sets of valves, or 'throw away' a working valve just because its partner has failed. With Rogue Audio's approach, you can replace just a single valve and be assured of restoring the amplifier to its designed performance level.

Listening Sessions

Before settling in to listen to the M-150s, I thought I'd better set the valve bias, particularly since it all seemed fairly straightforward. First you have to loosen the four screws on the 'hatch' in the middle of which is set the bias meter. This is easy to do, using only your fingers, particularly since the screws are captive, so they can't fall out, and spring-loaded, so the spring forces the screw up as you turn it. Then, I had to locate the bias tool that was supposedly 'snap attached to the inside of the cover.' Oops. No it wasn't… nor was there any place where it *could* be so attached, therefore I deduced things have obviously changed since the manual was written (the issue date on mine was shown as 10/27/03).

This is important because you can't use just any old screwdriver to adjust the bias. Firstly the slot is so small you need a screwdriver with a tiny and very narrow blade. Secondly (and most importantly) whatever screwdriver you use should have a fully insulated handle, and the area around the blade should preferably be encapsulated. Such tools are available only from specialist electronics stores. Such tools are, however, absolutely necessary to ensure protection against electric shock (the voltages inside valve amplifiers are far, far higher than those inside solid-state amplifiers, which are dangerous enough) and also protection for the amplifier, so that if you accidentally drop the tool inside it, it won't short out anything.

Once I actually started setting bias, things got a little interesting. Valve 1 was fine, so I didn't touch it. Valve 3 was a little low so I brought it up to 40mA. Valve 2 was fine, but Valve 4 was a little high, so I bought it down. When I then went back to Valve 3 I found it had subsequently gone a little high, so I brought it down, which sent Valve 4 a touch high again… you get the idea. It was still an easy-enough process, but not quite the 'piece of cake' the manual made out it would be. The process is also further complicated by the fact that the needle on the meter doesn't move predictably when you're turning the adjustment screw. By this I mean that if a quarter-turn on the screw moves the needle 2mm up the scale, another quarter-turn on the screw doesn't necessarily mean the needle will move a further 2mm up the scale. Finally, I personally found it more than a little awkward to access the toggle switches used to connect the meter to each tube, but this is a very minor point and probably reflects the size and dexterity of my fingers more than any failing on Rogue Audio's part.

Setting the bias is not a once-only affair. Even Rogue Audio says 'tube bias should be checked on a regular basis'—though the company gives no guidelines as to exactly how often it should be checked. Since I was reviewing the amplifier, I checked the bias before each daily listening session and after a few weeks I'd refined the process to an art, so it took only a few minutes each time, if it needed to be done at all. If I wasn't actually reviewing the amplifier, I think I'd settle for checking it only on a weekly or fortnightly basis… or maybe, since I'm lazy, at least once a month! Though, of course, if you hear any distortion when listening to music, you should check the valves straight away!

The only difficulty with adjusting the bias regularly is that you have to ensure easy access, so there'll be no hiding the M-150s away. Not that you'd want to, of course, because they look great, and also not that you could even do so easily even if you wanted to, because the M-150s are not exactly small. Each one weighs around 25kg and measures 370 × 485 × 180mm (WDH) and requires plenty of ventilation. Providing easy access to the rear of the unit, so you can see the meter, may require some ingenuity (or a rotating platform).

Then you'll need to make a decision as to which output tap to use. This is easy enough if your speakers are rated at 8Ω or 4Ω, but my speakers are nominally 6Ω! In my case, I found after trying both positions that the 8Ω tap was clearly superior. However, when I tried a pair of 4Ω bookshelf speakers just to see how the M-150 would drive them, I preferred their sound when they were connected to the 8Ω tap as well! My advice is to spend some time intensively evaluating your speakers with both taps, then connect to the tap that gives the best sound quality, irrespective of what the 'nominal' impedance of your speakers is supposed to be.

That out of the way, you'll need to make a decision about whether to listen in triode or ultralinear mode. It's here that things went awry in my listening sessions, because I regularly preferred one mode over another depending on the music I was playing and at times, I liked to use different modes with the same music, depending on how I was feeling at

the time. Without going into too many specifics about my own personality, and given that there were exceptions, it turned out that I nearly always preferred the ultralinear mode when I was feeling on top of the world and listening to upbeat, bouncy music, and nearly always preferred the triode mode when I was feeling a bit depressed or down. In the in-between times, I mainly selected the mode depending on how loud I was able to listen, because there was definitely more 'oomph' on tap in the ultralinear configuration.

And oomph is certainly what I experienced when Vinnie Colaiuta laid into his kit on Andy Summers' 'Earth + Sky', which gets into the groove right from the opening track *Above the World*. Actually, Vinnie doesn't so much lay into his kit as drum effectively: the difference is that the drum sound on this CD is really, *really* clean, particularly the kick drum, hence the bit about the oomph. The Rogue Audio really delivers the kick *and* the overhang: it's a great sound.

One fault with the miking on 'Earth + Sky' is that the cymbals are too closely miked, so they tend to blur into white noise on some amp/speaker combinations, but listening through the Rogue Audios, I thought a little of the heat was taken from the sizzle, so I ended up with a nice overall balance. In the upper bass, I thought the Rogue rendered the sound of Abraham Laboriel's bass just a little full, but it was nonetheless nice and easy to listen to, and the pitching was perfect. This is particularly easy to hear on *The Diva Station*. After you've done this, admire to the glorious tone of Andy Summers' guitar on *Return:* it's just so 'out there' and 'guitary'. I can't remember Summers playing like this when he was with The Police. All I can't understand is why they let Dennis Smith go ape with his crevulation modulator. I have no idea what it is, but I assume it's responsible for the weird phasing effects on this CD. I don't think this album needed it.

For some reason the crevulation modulator reminded me of Phil Spector, so I dragged out *Walking in the Rain*... but only for a moment—horrible song and didn't sound any better than I remembered it through the M-150s. But it did lead me on to have a lot of fun

with the Ted Mulry Gang's *Jump in my Car* which sounded fabulous through the Rogue M-150s, and just like I remember it sounding when I heard it played live in some pub in Newcastle. Then it was on to one of my all-time faves: Glen Campbell's hilarious *I Knew Jesus (Before He Was A Star)*, which gave the Rogue Audio no trouble at all. I was pleasantly surprised to find I could hear all the instruments clearly through the grungy mix, and that despite the multi-layered sound, I could wind the volume up to the max without the sound becoming confused.

By now feeling like something a bit more modern, but wanting to stick with the 'oldies' theme, I had running, I fired up the Rolling Stones' *Don't Stop* from '40 Licks.' What a great rocker! And you gotta love the lyric: '*Well you bit my lip and drew first blood/And wore my cold, cold heart/And you wrote your name right on my back/Boy your nails were sharp/But don't stop honey.*' By this time I was really having fun with the Rogue Audio amps and it was time for some Joe Cocker—not the old stuff, but his eminently respectable 'Respect Yourself.' I think he does a great job on the Andrew Farris/Michael Hutchence classic *Never Tear Us Apart*—ramp up the volume on the signature guitar intro to the second stanza with the beautiful line *I'd make wine from your tears* and weep. John Shanks is the guitarist, and he also plays a mean lead break (too short, regrettably) before the last stanza, that is reproduced in all its grungy glory by the Rogue Audio M-150s.

Conclusion

I liked everything about the Rogue Audio M-150s, from their clean-edged, no-non-sense design to the take-no-prisoners sound quality which although it was unmistakably valve-based at heart, offered more than a passing wave to the very best that solid-state designs have to offer, not least because it was remarkably non-microphonic, but also because of its detail and the lack of hardness in the highs.

Peter Croft

LAB REPORT

Readers interested in a full technical appraisal of the performance of the Rogue Audio M-150 should continue on and read the LABORATORY REPORT published on the following pages. All readers should note that the results mentioned in the report, tabulated in performance charts and/or displayed using graphs and/or photographs should be construed as applying only to the specific sample tested.

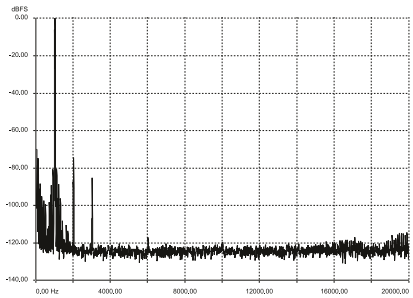
Test Results

Measuring the power output of the Rogue Audio M-150 was complicated because the two modes—triode and ultralinear—result in different power outputs, and it's theoretically possible to configure the output six different ways, so in all, there are 12 different combinations that will result in completely different power outputs.

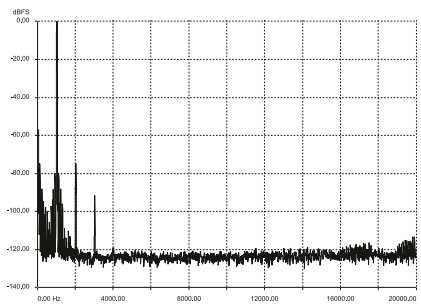
As you can see from the tabulated test results, there was one area where all gave exactly the same result, which is at 20kHz, where the maximum undistorted output power (that is, less than 0.1% distortion) was just 10-watts (or 10dBW, when the output is in dB referred to one watt). Above 10-watts the waveform starts skewing, which lifts distortion to around 2.0%, where it remains relatively constant until 40-watts is reached, upon which the waveform becomes almost unrecognisable as a sine wave. Although this technically limits the 20Hz –20kHz power to less than 30-watts, the amplifier will never have to reproduce a 20kHz signal at even this level, because there isn't this type of energy in music up at this frequency. And what this means is that even if you were running the amplifier flat-out with music at the amplifier's maximum 1kHz power output (which is 168-watts), the amount of power output required at 20kHz would actually be less than 10-watts, due to the spectral distribution of music. There's also the possibility that the high-frequency power output would increase with different valves. The samples were tested with the 6550s supplied with the amplifier, whereas I personally think KT88s (which plug straight in) may have provided superior performance. (EL34s are yet another option.)

There are two sets of tabulated power output figures. One shows the amplifier's performance with three different loads (8Ω, 4Ω and 2Ω) connected to the 8Ω tap (in which case the 4Ω and 2Ω loads are wildly mismatched) and the other with the same three loads connected to the 4Ω tap (in which case the 8Ω and 2Ω loads are mismatched by equal amounts). Rather than the normal 'one-channel-driven' and 'two-channel-driven' figures that are normally shown in this table, you'll see the left-most column shows whether the result was gained with the (mono) amplifier in triode mode or ultralinear mode. With

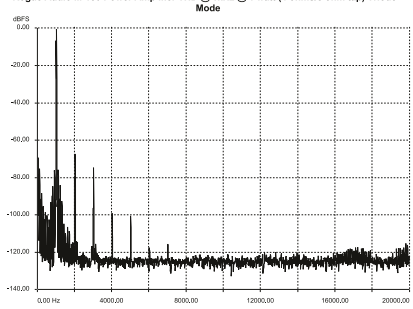
Rogue Audio M-150 Power Amplifier THD @ 1kHz @ 1 watt (8 ohms) Triode Mode



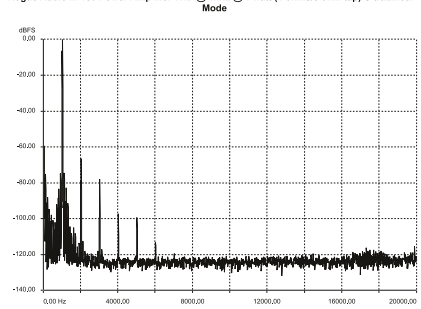
Rogue Audio M-150 Power Amplifier THD @ 1kHz @ 1 watt (8 ohms) UltraLinear Mode



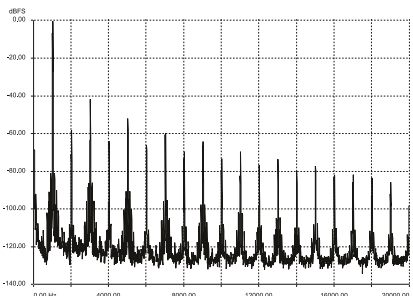
Rogue Audio M-150 Power Amplifier THD @ 1kHz @ 1 watt (4 ohms/8 ohm tap) Triode Mode



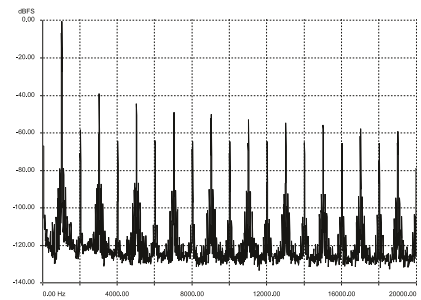
Rogue Audio M-150 Power Amplifier THD @ 1kHz @ 1 watt (4 ohms/8 ohm tap) UltraLinear Mode



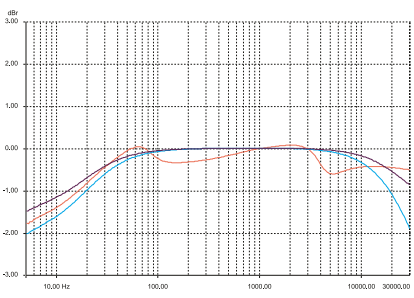
Rogue Audio M-150 Power Amplifier THD @ 1kHz @ 90 watts (8 ohms) Triode Mode



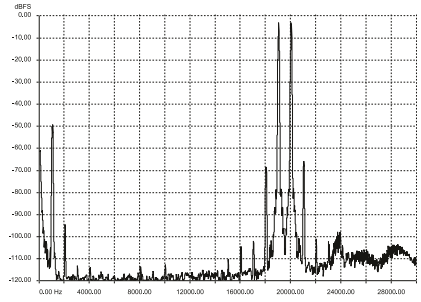
Rogue Audio M-150 Power Amplifier THD @ 1kHz @ 150 watts (8 ohms) UltraLinear Mode



Rogue Audio M-150 Power Amp. Freq. Resp. @ 1 watt (Sim L/S, 8 ohm tap) Triode Vs Ultralinear



Rogue Audio M-150 Power Amplifier IMD @ 19/20kHz @ 2 watts @ 8 ohms



an 8Ω load connected to the 8Ω tap, and a 1kHz test frequency, the Rogue Audio M-150 delivered around 100-watts in triode mode, and around 170-watts in ultralinear mode. You can see the actual tabulated results are actually one or two watts above or below these levels, but since valve amplifiers don't go into hard clipping anyway, and the differences are within test measurement error, consider the maximum output as 170-watts, which is 20-watts (1.2dB) greater than Rogue Audio's power output claim of 150-watts. Interestingly, the M-150's output at 20Hz was slightly higher than it was at 1kHz, which is the opposite of what often happens with solid-state amplifiers, though this was true only for the ultralinear mode.

Tested with the 4Ω speaker tap, the M-150 produced the maximum power when driving a 4Ω load, as expected, though in this case the output was 156-watts (ultralinear) vs 72 watts (triode). However, you can see that, all other things being equal, the performance of the M-150 seems to be clearly superior when using the 8Ω tap compared to the 4Ω tap. However, although you might develop more power with the 8Ω tap you will suffer increased distortion, as is shown in the following paragraphs.

Distortion at the 1-watt output level was relatively low, and surprisingly, there was very little difference between the ultralinear and triode modes when the 8Ω tap was matched with an 8Ω load. As you can see, the second harmonic was at –75dB (0.01%) and the third harmonic at –90dB (0.003%) in triode mode, increasing to –85dB (0.006%) in ultralinear mode. The jagged peaks surrounding the fundamentals indicate power supply noise in both cases, but it's more than 90dB down, though the noise itself (the peak at the far left) is at –70dB. Note the noise floor above 2kHz is hovering below –120dB, which is an excellent result.

Distortion increased when the output transformer and the load were mismatched, so that when the 8Ω tap was driving a 4Ω load, the level of second harmonic distortion rose to around –70dB (0.03%) [slightly less in triode mode]. The level of the third harmonic component was actually slightly higher in triode mode, at –75dB (0.01%). Harmonic distortion components are visible out to the 7th (at 7kHz), but in terms of contributing to sound, even the levels of the second and third harmonics are too low to be significant. The overall THD+N figure was a very good 0.08%.

Distortion was very high at rated output, in either ultralinear or triode modes. Since Rogue Audio doesn't state a maximum output for the triode mode, *Australian HI-FI Test Laboratories* picked an arbitrary level below 'clipping' which transpired to be 90 watts. Looking at the 150-watt output spectrum, you can there are odd-order harmonic distortion components stretching from the 3rd to the 19th, all of which hover between –40dB (1.0%) and –50dB (0.3%). The even-order distortion components are lower in level, but also extend right across the audio band, from the 2nd at –58dB (0.12%) to the 18th at –65dB (0.05%). Bad though this looks on the graph, the total THD+N figure actually works out to only 1.1%, which is very good for a valve amplifier working this hard, and from the evidence of the listening sessions, didn't appear to be audible. (Again, the jagged lines clustered around the bases of the harmonic distortion components are caused by the power supply.)

Intermodulation distortion was also high. In this case, *Australian HI-FI Test Laboratories* has used a so-called 'twin-tone' IMD test signal, which injects 19kHz and 20kHz sine waves into the amplifier at equal levels. As you can see on the graph, the Rogue Audio M-150

Rogue Audio M-150 Mono Valve Power Amplifier - Power Output using 8 ohm tap

Mode	Load (Ω)	20Hz (watts)	20Hz (dBW)	1kHz (watts)	1kHz (dBW)	20kHz (watts)	20kHz (dBW)
Triode	8Ω	98	19.9	98	19.9	10*	10.0
Ultralinear	8Ω	171	22.3	168	22.2	10*	10.0
Triode	4Ω	100	20.0	100	20.0	10*	10.0
Ultralinear	4Ω	169	22.2	156	22.2	10*	10.0
Triode	2Ω	85	19.2	85	19.2	10*	10.0
Ultralinear	2Ω	144	21.5	128	21.5	10*	10.0

Note: Figures in the dBW column represent the output level, in decibels, referred to one watt output.

Rogue Audio M-150 Mono Valve Power Amplifier.

Test	Measured Result	Units/Comment
Frequency Response @ 1 watt	13Hz–45kHz	–1dB
Frequency Response @ 1 watt	2.2Hz–71kHz	–3dB
Channel Separation	N/A	(20Hz/1kHz/20kHz)
Channel Balance	N/A	@ 1kHz
Interchannel Phase	N/A	deg (20Hz/1k/20k)
THD+N	0.08% / 1.1%	1 watt/rated o/p
S/N Ratio (unweighted/weighted)	70.0dB/90.0dB	dB re 1 watt output
S/N Ratio (unweighted/weighted)	90.0dB/110.0dB	dB re rated output
Input Sensitivity (CD input)	72mV/856mV	(1 watt/rated o/p)

Rogue Audio M-150 Mono Valve Power - Power Output using 4 ohm tap

Mode	Load (Ω)	20Hz (watts)	20Hz (dBW)	1kHz (watts)	1kHz (dBW)	20kHz (watts)	20kHz (dBW)
Triode	8Ω	72	18.5	72	18.5	10*	10.0
Ultralinear	8Ω	120	20.7	112	20.4	10*	10.0
Triode	4Ω	90	19.5	72	18.5	10*	10.0
Ultralinear	4Ω	169	22.2	156	21.9	10*	10.0
Triode	2Ω	98	19.9	98	19.9	10*	10.0
Ultralinear	2Ω	200	23.0	145	21.6	10*	10.0

Note: Figures in the dBW column represent the output level, in decibels, referred to one watt output.

generates sideband signals at 17kHz and 21kHz at levels of around –70dB (0.03%), but more musically significant is the unwanted regenerated difference tone at 1kHz, which is at –50dB (0.3%).

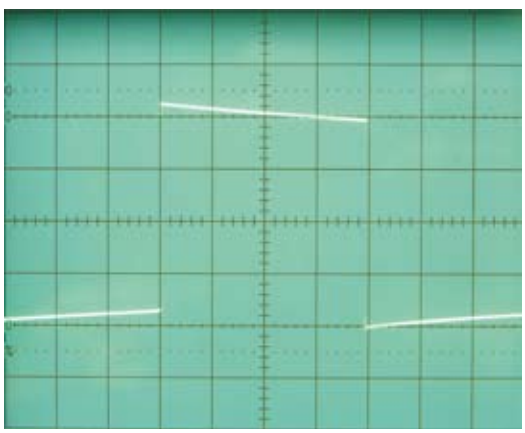
The Rogue Audio M-150's measured frequency response was very good, extending from 13Hz to 45kHz –1dB, and from 2.2Hz to 71kHz –3dB. This shows both good circuit design and excellent transformer characteristics. The frequency response between 5Hz and 30kHz is graphed for ultra linear mode (black line) and triode mode (blue line) into an 8Ω non-inductive resistor. You can see the ultralinear mode is more linear but there's not a lot in it, with the triode mode just 0.5dB below the ultralinear at 20Hz and only 1dB below the ultralinear at 30kHz. The extra (red) trace on the graph shows the Rogue Audio M-150's response (in ultralinear mode) into a simulated loudspeaker load. The lack of variation indicates that the M-150's output impedance is very much lower than I'd have expected for a valve amplifier and, as a result, the amplifiers' performance will not be too-much affected by your choice of loudspeaker: something that's certainly not true of most valve amplifiers.

The Rogue Audio M-150 also proved to be very quiet, if you hadn't already guessed this from looking at the noise floor on the distortion graphs. At an output level of one watt, the signal-to-noise ratio was 70dB unweighted (that 50Hz hum component noted earlier), but with industry-standard A-weighting, this figure improved dramatically, to 90dB. At rated output, the unweighted signal-to-noise ratio was measured at 90dB, improving to 110dB—a figure any modern solid-state high-end power amplifier would be glad to claim!

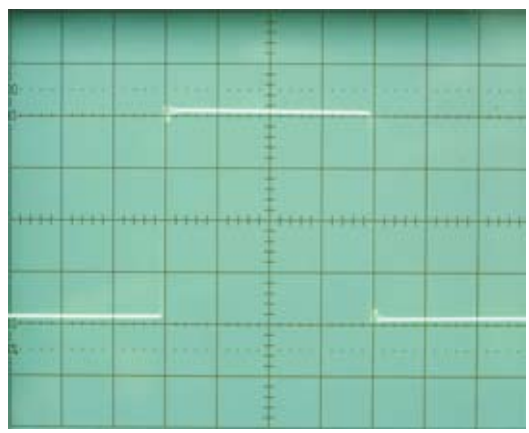
Input sensitivity was a little 'better' (that is, more sensitive) than the 1-volt claimed by Rogue Audio, with the test sample requiring only 856mV at its input to deliver rated output. To deliver an output of one watt, just 72mV is required. Provided your CD player has a volume control, you could easily connect it directly to a pair of M-150s. Likewise, any pre-amp (active or passive) could be partnered with them.

Square wave performance was remarkably good, particularly the result with a 10kHz test signal, which would put most solid-state designs to shame: just look at that leading edge! The 100Hz square wave shows the tilt expected by the slight restriction on the low-frequency response, as well as some very slight curvature that would indicate a touch of group delay over the bandwidth. The 1kHz waveform is excellent. It would be textbook were it not for the very slight ringing. This tiny amount of ringing was then exaggerated when the amplifier's output was also loaded with a 2µF capacitor in parallel with the 8Ω resistor, to simulate an extremely badly designed dynamic loudspeaker, or an electrostatic design. In fact, the amplifier is exceedingly well behaved into this highly capacitive load.

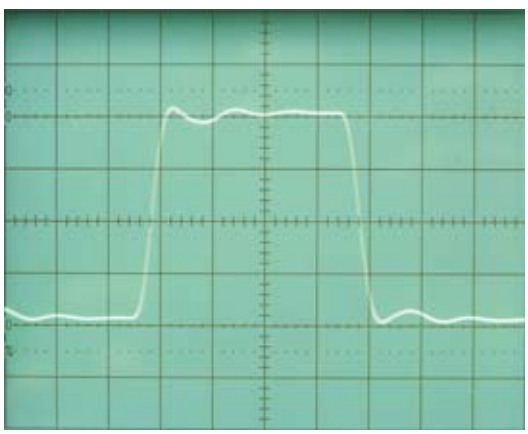
I was most impressed with the Rogue Audio M-150's performance, which I thought was excellent. *Steve Holding*



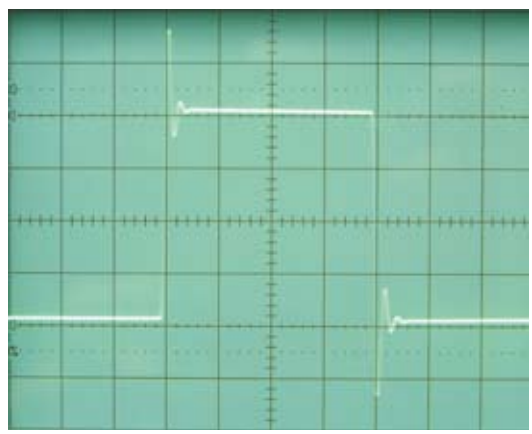
100Hz Square Wave (8Ω resistive load)



1kHz Square Wave (8Ω resistive load)



10kHz Square Wave (8Ω resistive load)



1kHz Square Wave (8Ω//2µF capacitive load)